

# CuInGaAlSe<sub>2</sub> Solar Absorbers On Flexible High-Temperature Substrates, Phase I

Completed Technology Project (2005 - 2005)



## Project Introduction

ITN Energy Systems (ITN) proposes to take the next step in spacecraft solar array development, building upon previous development and new findings to make the definitive light-absorber layer for high-power, lightweight and flexible thin-film photovoltaics (TFPV). ITN's innovative approach is to alloy CuInSe<sub>2</sub> (CIS) with both aluminum and gallium bandgap widening elements in the chalcopyrite matrix to form CuInGaAlSe<sub>2</sub> (CIGAS) for simultaneous optimization of the bandgap and material properties. Both Ga and Al will be used to take advantage of the alloy enhancing properties that each offers when used in moderation, while avoiding the detrimental issues when using too much of any one element to achieve the optimum bandgap of about 1.45 eV for a single-junction in the space solar spectrum. Furthermore, a recently available novel lightweight, flexible and transparent substrate will be used that was specifically designed to enable high-temperature CIGAS depositions as needed for the highest efficiency TFPV. TFPV specific power of over 1500 W/kg at the blanket/module level would be achievable. The novel transparent substrates would also enable additional power from bifacial visible light collection and lower temperature operation, from improved infra-red (IR) transmission, in addition to enabling TFPV fabrication by low-cost roll-to-roll processing.

## Anticipated Benefits

Two of the most important, near-term markets for high-efficiency flexible lightweight photovoltaics are spacecraft and aerostats/high-altitude airships (HAA). The target customers for this market are aerospace companies, defense, and communications industries. The largest market is in the evolving HAA industry, but there is also an opportunity in the well-established satellite community. Market projections indicate that approximately 16.5 MW of flexible thin film PV power will be launched for HAA's, and 1.0 MW of space PV power will be launched between 2007 and 2011. In the long term, as the costs eventually come down with manufacturing process improvements and economies of scale, the PV space/HAA product technology can be leveraged for the implementation of the low-cost monolithic tandem PV terrestrial product. The terrestrial PV market is projected to be a \$163 ? 302 M (min and max estimates) per year market by 2010 for thin-film technologies in North America alone, with a compound annual growth rate between 16.1% and 32.3%.



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## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Glenn Research Center (GRC)

### Responsible Program:

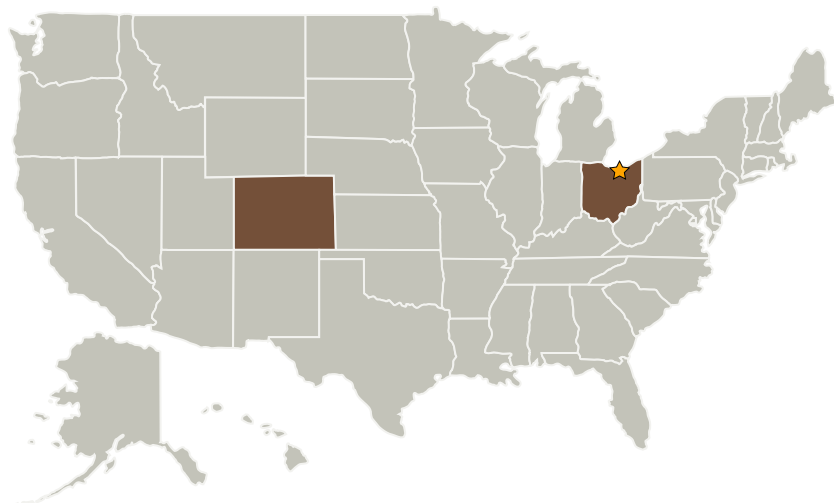
Small Business Innovation Research/Small Business Tech Transfer

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
ITN Energy Systems, Inc.	Supporting Organization	Industry Minority-Owned Business	Littleton, Colorado

## Primary U.S. Work Locations

Colorado	Ohio
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## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Project Manager:**

Jeremiah S Mcnatt

**Principal Investigator:**

Lawrence A Woods

## Technology Areas

**Primary:**

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.1 Photovoltaic